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ABSTRACT

This document describes seven science activities that combine scientific principles and computers. The objectives for the activities are to show students how the computer can be used as a tool to store and arrange scientific data, provide students with experience using the computer as a tool to manage scientific data, and provide students with experience building computer data base files for use in science. Activities were introduced to elementary school teachers during an inservice workshop where they were trained to use an AppleWorks data base program with the Apple IIGS computer. Students who conduct the activities use research team processes, data pooling techniques, and computers as they attempt to make sense out of random data. Each activity includes: (1) grade level; (2) science skills; (3) math skills; (4) computer skills; (5) vocabulary; (6) list of variables; (7) materials; (8) procedures; and (9) curriculum extensions. Topics covered are: weight and counting using toothpicks and M&M's; the student's own personal data such as height, weight, and eye color; levers; acids and bases; and fire and atmospheric pressure. (KR)

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INTEGRATING DATA BASE INTO THE ELEMENTARY SCHOOL SCIENCE PROGRAM

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INTEGRATING DATA BASE INTO THE ELEMENTARY SCHOOL SCIENCE PROGRAM

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April 1990

TABLE OF CONTENTS

TOPIC

Introduction

Activities

1. Integrating Computers Into Elementary Science Using Toothpicks
2. Integrating Computers Into The Science Program Using M & M's
3. First Grade Science With Apples
4. Studying Second Class Levers
5. Buttons Computers And Data Base
6. Testing For Acids And Bases
7. Studying The Chemistry Fire And Atmospheric Pressure

INTRODUCTION

Integrating Data Base Into The Elementary School Science Program was designed as a three half days an over the shoulder data base file construction workshop. Kindergarten through grade two teachers meet on one day. Grades three and four teachers meet on another day and the third day is reserved for grades five and six teachers. Each teacher attending a session has a an Apple IIGS computer for his or her exclusive use during the workshop.

Participants are introduced to the development of computer data base files exactly as students might be introduced to them in a science class. The workshop starts with a brief discussion about using the computer as a tool and data organization. The discussion is followed by an activity where participants gather data the nature of which depends upon the grade levels grouping. A computer data base file is subsequently constructed and the data entered in the file. The file is arranged, rearranged, printed and prints examined to see if data trends exist.

Additional data are provided to participants and data base files constructed depending upon the amount of time available. Each teacher participant is provided with a copy of this booklet as part of the workshop materials.

ACTIVITIES

Several science activities having data base components are included here. At first glance, some of the activities may appear to sophisticated for some levels of students or not sophisticated enough for others. The activities can be used in any elementary grade, if the degree of sophistication with which they are offered is altered to meet the ability levels of a particular group of students. Our objectives when using these activities with students are:

1. To show students how the computer can be used as a tool to store and arrange scientific data.

2. To provide students with experience using the computer as a tool to manage science data.

3. To provide students with experience building computer data base files for use in science.

INTEGRATING COMPUTERS INTO ELEMENTARY SCHOOL SCIENCE USING TOOTHPICKS

INTRODUCTION

In this activity, students gather data from packages of colored toothpicks. While collecting data, students work in research teams. After students collect the data, the data is shared between all research teams. Subsequent to the data collection phase of the investigation, participants build AppleWorks data base files using Apple IIe or GS computers, print, save and electronically manipulate the files, examine the computer printouts and attempt to draw conclusions based upon examination of the data. The level of sophistication with which the activity is approached and teacher expectations of student outcomes should become higher and more complex as the grade level increases. Grade 3 students, for example, might be expected to gather data regarding numbers of each color of toothpicks and the total number of toothpicks in each package followed by building and entering data into a data base file. Grade 8 research teams might calculate percentages of various colors in a package, the average number of all of the different colors and so on.

Teachers who desire to use this activity should know how to construct, save, arrange and print AppleWorks data base files.

PRESENTATION

One thing to note is whether or not toothpicks are packaged by weight. You should expect a variation in the number of toothpicks in each color category and the total number of toothpicks in each small package assuming that each student has the same kind of package. Toothpicks are produced in yellow, green, pink, blue and perhaps other colors.

Grade Level. Grades 1 through 9.

Science Skills.
1. Categorizing.
2. Classifying.
3. Data Collection.
4. Data Manipulation.
5. Observing.
6. Drawing Conclusions.

Computer Skills.
1. Program Loading.
2. Disk Formatting.
3. Data Base File Construction.
4. File Storage.
5. Data Entry.

Math Skills.
1. Addition.
2. Averaging.
3. Computing Percentage.
4. Less Than.
5. Greater Than.

Vocabulary.
1. Variable.
2. Data.
3. Data Base.
4. Format.
5. Load or Boot.
6. File.
7. Store.

6. File Manipulation.
7. File Printing.
8. Arrange.

Partial List Of Variables.
1. Color.
2. Number of toothpicks in each package.
3. Mass of each toothpick.

Materials.
1. 1 package of toothpicks for each pair of students.
2. At least 1 Apple IIe or GS computer with printer for each class.
3. 1 copy of the AppleWorks program for each computer (versions 1.2, 1.3, 2.0 and 2.1 may be used; V2.0 and V2.1 normally used only with the IIGS).
4. 1 blank data disk for each class.
5. 1 pencil for each student.
6. 2 sheets of paper for each student.

Procedures.
1. Establishing Research Teams. Divide the class into pairs of students.
2. Materials Handout. Give each research team:
   a. 1 pencil.
   b. 2 pieces of paper.
   c. 1 package of toothpicks.
3. Inquiry Period. Allow the research teams approximately 5 minutes during which they are encouraged to learn all they can about the toothpicks using their own skills and the implements they have.
4. Brainstorming. Conduct a brainstorming session during which the class identifies the variables to be investigated. They should be led to identify color and number. Further, number for each color and total number should be identified.
5. Chalkboard. Write the variables on a chalkboard or a flipchart.

COLOR	NUMBER
YELLOW	
GREEN	
PINK	
BLUE	
OTHERS	_____
TOTAL	

Figure 1. An Example Data Gathering Table.

```
File: DB01516.009              REVIEW/ADD/CHANGE              Escape: Main Menu
Selection: All records

SAMPLE.NO PINK %P    GREEN %G    BLUE %B    YELLOW %Y    TOTAL.NO TL.MASS(gm)
==========================================================================
-         -  -      -  -      -  -       -  -         -  -         -
```

```
Type entry or use á commands                                  á-? for Help
```

Figure 2. An Example Data Base File.

6. Construction of a Data Table. Conduct a brief class period where the construction of a data gathering table is discussed.
7. Construction Period. Allow a period during which each research team constructs a data gathering table (see Figure 1).
8. Data Gathering Period. Allow a period where students gather data about the variables.
9. Computing Average. For older students, provide the formula for computing the average number of each color which should be in each container:

$$\frac{\text{TOTAL NUMBER OF TOOTHPICKS IN THE PACKAGE}}{\text{TOTAL NUMBER OF COLORS}}$$

10. Computing Percent. For older students, provide the formula for computing the percent of each color that is found in each container:

$$(\text{COLOR}/\text{TOTAL NUMBER OF TOOTHPICKS IN A BOX}) \times 100$$

11. Computation Period. Allow time for the research teams to do the computations.
12. Data Sharing. Allow a period during which each student is provided the data gathered by every research team (you may want to provide students copies of the data gathering table).
13. Data Base File Construction. Have each student construct a data base file (see Figure 2). The students' last names could be used as file names. A sample is the data gathered by a single research team. There is a record (horizontal line) in the file for each team.
14. File Saving. Save the data base file by pressing the OPEN-APPLE and "S" keys at the same time.
15. Data Entry. Have each student enter all the data into his or her data base file.
16. File Saving. Save the file.
17. File Printing. Print the file by pressing the OPEN-APPLE and

"P" keys at the same time and then following the directions shown on the monitor screen.

18. File Manipulation. Manipulate the file, arranging it successively on each category. This is accomplished by pressing the OPEN-APPLE and "A" keys at the same time. The file should be printed each time a new arrangement is made (See Figure 3).
19. Data Examination. Allow a period where students examine the computer printouts (in research teams) looking for data trends.
20. Class Discussion. Conduct a class discussion where the findings of the activity are examined.

File: DB01516.009 REVIEW/ADD/CHANGE Escape: Main Menu

Selection: All records

SAMPLE.NO	PINK	%P	GREEN	%G	BLUE	%B	YELLOW	%Y	TOTAL.NO	TL.MASS(gm)
1	43	28.3	34	22.4	41	27.0	34	22.4	152	38
2	34	-	37	-	38	-	34	-	157	38
3	44	-	-	-	-	-	-	-	-	38
4	44	-	-	-	-	-	-	-	-	38
5	45	-	-	-	-	-	-	-	-	38
6	45	-	-	-	-	-	-	-	-	38
7	46	-	-	-	-	-	-	-	-	38
8	47	-	-	-	-	-	-	-	-	38
9	47	-	-	-	-	-	-	-	-	38
10	47	-	-	-	-	-	-	-	-	38
11	48	-	-	-	-	-	-	-	-	38
12	49	-	-	-	-	-	-	-	-	38

Type entry or use @ commands @-? for Help

Figure 3. An Example of a Data Collection Report.

Curriculum Extension.

1. Report Writing. Write a report about the project, using the word processing function of the AppleWorks program.
2. Story Writing. Write a story about the project.
3. Letter Writing. Write a letter to a friend describing the project.
4. Business Letters. Write a business letter to the company asking why its not possible to include the same number of each color of toothpicks in each container.
5. Statistical Computations. Have advanced students compute the median, mode and standard deviation. This will require assigning a number value like 1, 2, 3, 4, 5 for each color.
6. Making Sculptures. Use toothpicks and glue to create a design or a sculpture. See if you can use all of the toothpicks in a box (some students may also consider color patterns in their designs

or sculptures).

SUMMARY

Students who conduct this activity use research team processes, data pooling techniques and computers as they attempt to make sense out of random data. The activity is "hands-on" and allows use of the collective experiences of all participants by each participant.

INTEGRATING COMPUTERS INTO THE SCIENCE PROGRAM USING M & M's

INTRODUCTION

Have you ever met a student, young or old, who, when given the chance to eat M & M's in class, cast the opportunity aside? Well, there are a few around but not many. For many students, eating M & M's in science class while collecting, categorizing and arranging data is a real treat of high motivational value.

In this activity, students gather data from bags of M & M's. While collecting data, they work in research teams and following a data collection period, data is shared between all research teams. Subsequent to the data collection phase, participants build AppleWorks data base files using Apple IIe or GS computers, print, save and electronically manipulate the files, examine the computer printouts and attempt to draw conclusions based upon examination of the data. The level of sophistication with which the activity is approached and teacher expectations of student outcomes should become higher and more complex as the grade level increases. Grade 3 students, for example, might be expected to gather data regarding the numbers of each color of M & M's and the total number of M & M's per bag followed by building and entering data into a data base file. Grade 8 researchers might calculate percentages of various colors in a bag and so on.

Teachers who desire to use this activity should know how to construct, save, arrange and print AppleWorks data base files.

PRESENTATION

M & M's are packaged in a variety of different sized bags. When buying small bags we find several bags often packaged in a larger bag. One common sized larger package contains eight small bags. Be sure to purchase bags that are all the same size. This will allow students to gather accurate data for comparison between both small and larger bags. One thing to note is that M & M's are packaged by weight. You should expect a variation in the number in each color category and the total number in each small bag. This observation should also hold true for the comparison between large bags. M & M's are produced in dark brown, light brown, red, yellow, green and orange.

Grade Level. Grades 1 through 9.

Science Skills.
1. Categorizing.
2. Classifying.
3. Data Collection.
4. Data Manipulation.
5. Observing.
6. Drawing Conclusions.

Math Skills.
1. Addition.
2. Averaging.
3. Computing Percentage.

Computer Skills.
1. Program Loading.
2. Disk Formatting.
3. File Storage.
4. Data Base File Construction.
5. Data Entry.
6. File Manipulation.
7. File Printing.

Vocabulary.
1. Addition.
2. Data.
3. Data Base.
4. Format.
5. Load or Boot.
6. File.
7. Store.

Partial List Of Variables.
1. Color.
2. Number of M & M's per small bag.
3. Mass of each M & M.

Materials.
1. 1 small bag of M & M's for each pair of students.
2. At least 1 Apple IIe or GS computer with printer for each class.
3. 1 copy of the AppleWorks program for each computer (versions 1.2, 1.3, 2.0 and 2.1 may be used; 2.0 and 2.1 normally used only with the IIGS).
4. 1 blank data disk for each class.
5. 1 pencil for each student.
6. 2 sheets of paper for each student.

Procedures.
1. Establishing Research Teams. Divide the class into pairs of students.
2. Materials Handout. Give each research team:
   a. 1 pencil.
   b. 2 pieces of paper.
3. Inquiry Period. Allow the research teams approximately 5 minutes during which they are encouraged to learn all they can about the M & M's using their own skills and the implements they have.
4. Brainstorming. Conduct a brainstorming session during which the class identifies the variables to be investigated. The students should be led to investigate the following variables: color, number of M & M's and the total amount of M & M's in each package.
5. Chalkboard. Write the variables on a chalkboard or a flip chart.
6. Construction of a Data Table. Conduct a brief class period where the construction of data gathering table is discussed.
7. Data Table. Allow a period during which each research team constructs a data gathering table (Figure 1).
8. Data Gathering Period. Allow a period where students gather data about the variables.
9. Computing Average. For older students, provide the formula for computing the average number of each color which should be in each bag:

TOTAL NUMBER OF M & M's IN THE BAG
TOTAL NUMBER OF COLORS

COLOR	NUMBER
RED	_____
YELLOW	_____
GREEN	_____
ORANGE	_____
DARK BROWN	_____
LIGHT BROWN	_____
TOTAL	

Figure 1. An Example Data Gathering Table.

10. Computing Percent. For older students, provide the formula for computing the percent of each color that is found in each bag.

(COLOR 1/TOTAL NUMBER OF M & M's IN THE BAG) x 100

11. Computation Period. Allow a period where research teams do the computations.
12. Data Sharing. Allow a period during which every student collects the data gathered by every research team (you may want to provide students copies of the data gathering table).
13. Data Base File Construction. Have each student construct a data base file (see Figure 2). The students' last names could be used as file names. A sample is the data gathered by a single research team. There is a record (horizontal line) in the file for each team. The bag number is the large bag from which the small bag came.
14. File Saving. Save the data base file by pressing the OPEN-APPLE and "S" keys at the same time.
15. Data Entry. Have each student enter all the data into his or her data base file.
16. File Saving. Save the file.
17. File Printing. Print the file by pressing the OPEN-APPLE and "P" keys at the same time and then following the directions shown on the monitor screen.
18. File Manipulation. Manipulate the file, arranging it successively on each category. This is accomplished by pressing the OPEN-APPLE and "A" keys at the same time. The file should be printed each time a new arrangement is made.

19. Data Examination. Allow a period where students examine the computer printouts (in research teams) looking for data trends.
20. Class Discussion. Conduct a class discussion where the findings of the activity are examined.

Curriculum Extension.
1. Write a report about the project, using the word processing function of the AppleWorks program.
2. Write a story about the project.
3. Write a letter to a friend describing the project.

File: M M DATA BASE REVIEW/ADD/CHANGE Escape: Main Menu

Selection: All records

SAMPLE NO	BAG NO	RED	YELLOW	GREEN	ORANGE	DK BRN	LT BRN	TOTAL	AV	%
1	1	-	-	-	-	-	-	-	-	-
2	1	-	-	-	-	-	-	-	-	-

Type entry or use @ commands @-? for Help

Figure 2. An Example Data Base File.

4. Write a business letter to the company asking why its not possible to include the same number of each color M & M in each small bag.
5. Have advanced students compute the median, mode and standard deviation. This will require assigning a number value like 1, 2, 3, 4, 5 for each single M & M candy.

SUMMARY

Students who conduct this activity use research team processes, data pooling techniques and computers as they attempt to make sense out of random data. The activity is "hands-on" and allows use of the collective experiences of all participants by each participant.

FIRST GRADE SCIENCE AND APPLES

INTRODUCTION

John Dewey, early in the 20th century, stated that people learn by doing. Later, Piaget suggested concrete learning experiences to be of great value in facilitating conceptualization. Gagne points out that we learn more about a topic, process or combination there of if we deal with the phenomenon periodically, each successive time with an increasing degree of sophistication. Those ideas have been applied here to first grade

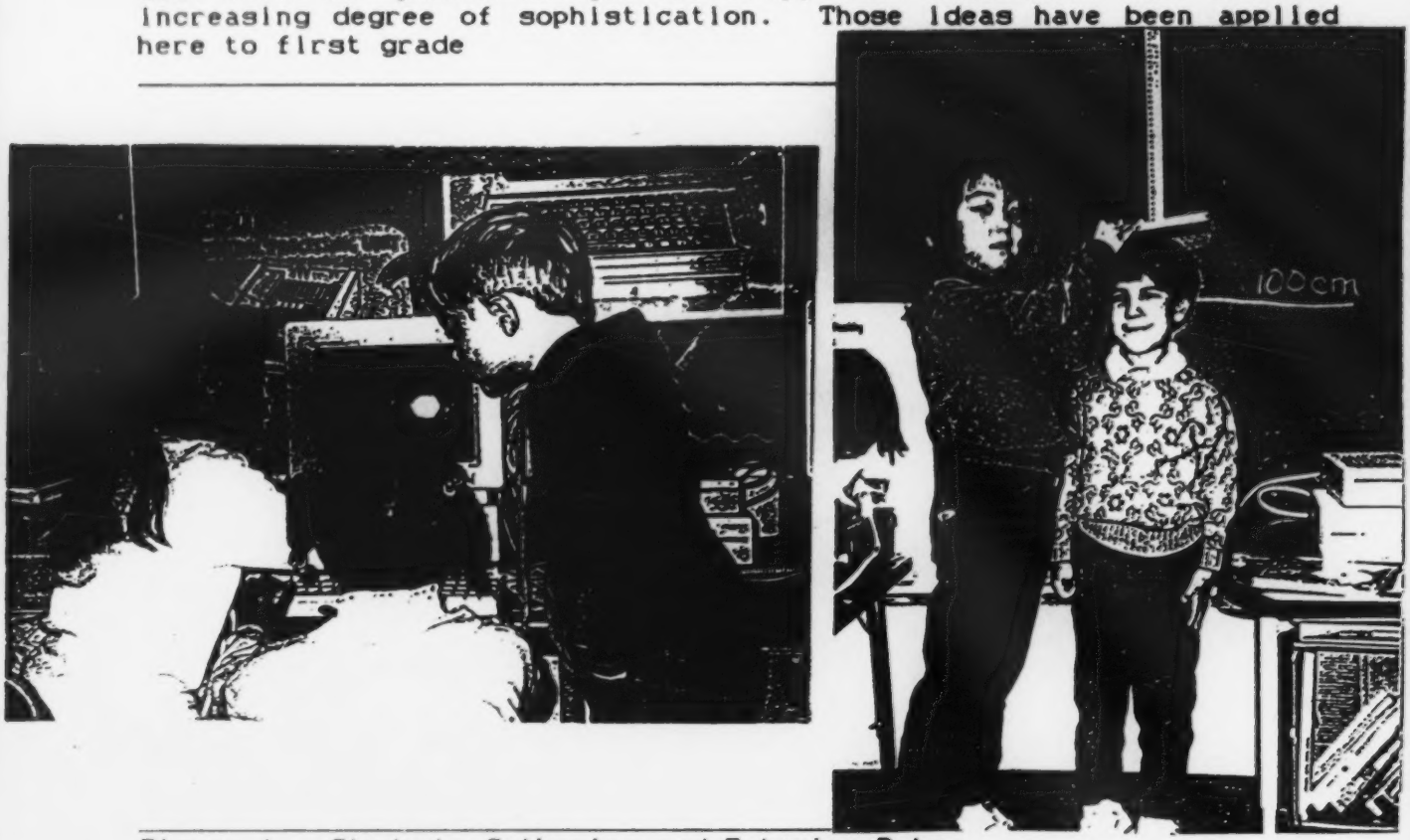

Figure 1. Students Gathering and Entering Data.

science as children are helped to gain experience using not only the scientific method but also the computer.

Part of the scientific method involves data gathering, organization and manipulation. This activity involves data gathering, organization, examination and crosses disciplines. The organization portion of the activity requires use of the Apple IIGS (Apple IIe may also be used) computer. The premise is that the computer is a tool used to gain greater understanding of the subject being studied more rapidly than is otherwise possible. Further, this idea is promoted. The data base portion of the AppleWorks program is used for data file development, data storage and subsequent data manipulation.

Children work in pairs as they gather the following data about themselves: height, weight, eye color, hair color, and age.

Materials
1. Apple IIe or GS computer system(s).
2. 1 floppy computer disk for data base file storage.
3. pencil and paper for each student.
4. 1 meter stick for each pair of students
5. bathroom scale(s) for the class. (Kilogram scales if available. If measured in pounds divide by 2.2 to obtain kilograms.)
6. Several large pieces of butcher or other paper.
7. Masking tape.
8. 1 ruler for each group of students.
9. AppleWorks computer program (versions 1.2, 1.3, 2.0, 2.1 or 3.0 are acceptable).

Science Skills
1. Measuring
2. Observing
3. Data Gathering
4. Data Analysis
5. Data Manipulation

Math Skills
1. Measuring
2. Reading a scale
3. Reading a meter stick

Computer Skills
1. Data base file construction
2. Data input
3. Keyboard Use

Vocabulary Development
1. Parallel
2. Centimeter
3. Computer
4. Pounds
5. Inches
6. Data Base
7. Category

Procedures
1. Wall Paper. Tape several pieces of large paper slightly higher than the heights of the students, at different locations on the classroom wall.
2. Grouping Students. Divide the class into groups of 2 children each.

DAY 1
3. Supplying Materials. Give each student a piece of paper and a pencil.
4. Supplying Materials. Give each group of students a meter stick and a ruler.
5. Writing Name. Have each student write his or her name on the paper.
6. Teacher Demonstration. Demonstrate how children should measure each other's heights by having a student stand straight with the back of his or her head against a piece of paper taped to the wall. The second child places a ruler on the first student's head and parallel to the floor and makes a mark on the paper (see Figure 2). The height is then measured with the meter stick. Measurements are made in centimeters.

7. Measuring Height. Have each student measure his partner's height and record it.

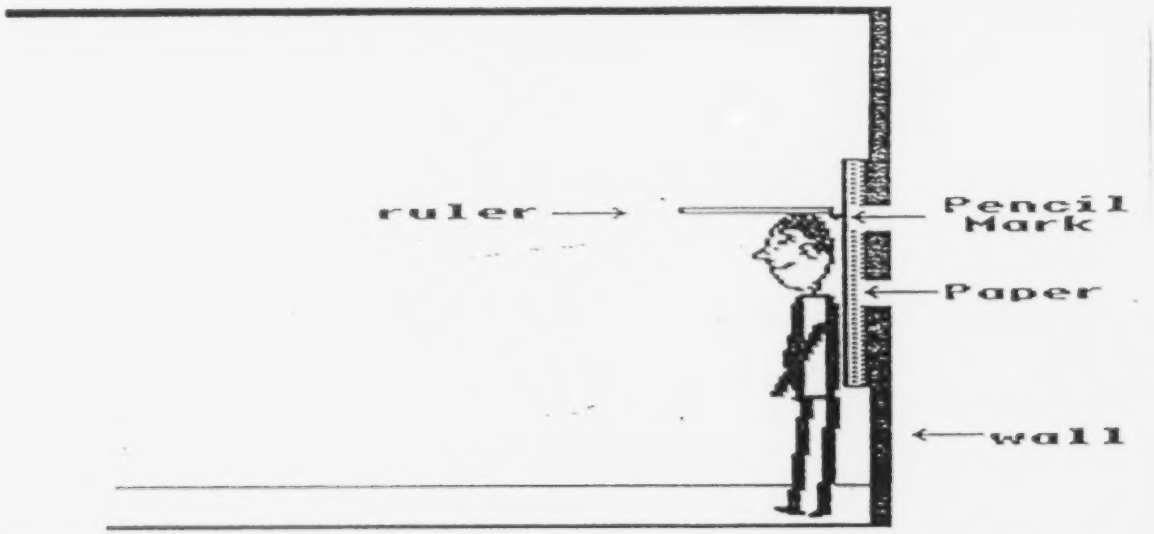

Figure 2. Measuring Height.

File: DB00483.005 REVIEW/ADD/CHANGE Escape: Main Menu

Selection: All records

NAME	HEIGHT	WEIGHT	EYES	HAIR	AGE
-	-	-	-	-	-
-	-	-	-	-	-

Type entry or use @ commands @-? for Help

Figure 3. Data Base File Prior to Entering Data.

DAY 2

8. Teacher Demonstration. Demonstrate how to read the weight scale.
9. Weighing Students. Have each student determine his or her partner's weight and record the weight.

DAY 3

10. Building A Data Base. Build or have students build a data base file which includes the following categories: name, height, weight, eye color, hair color and age (See Figure 3).
11. Teacher Demonstration. Demonstrate to students what is required to enter their own information in the data base file (be sure to save the file on the floppy disk prior to having children enter their data).
12. Data Entry. Have each student enter his or her own data in the computer.
13. File Storage. Insure that the file is stored following this portion of the activity.

DAY 4

14. Creating a Report. Place the cursor at the beginning of the category you wish to arrange. Arrange the file using the Open-Apple and the A key at the same time.
15. File Printing. Print each different arrangement of the file.
16. Printouts. Make copies of the computer printouts.
17. Student Materials. Give students copies of the printouts one at a time. Have them identify other students who have the same age, height, weight, eye color, hair color and sex.
18. Different Printouts. A different printout is used to show ordered arrangement of each category.

DAY 5

19. Question and Answer Session. Ask students to describe what the computer did that allowed them to find out who had the same eye color and so on as they.

File: FIRST.GRADE Page
Report: First Graders

NAME	HEIGHT	WEIGHT	EYES	AGE
ROSS, MONICA	116cm	40	BLACK	6
BENEDICT,AIMEE	123cm	41	BLACK	6
SABOURI,PASHA	113cm	42	BROWN	6
PERKINS,CARLA	115cm	42	BROWN	6
DELEON, CRYSTAL	117cm	42	BLACK	6
GAGNON,BETH	119	42	HAZEL	6
CZINSKI,DANIEL	121cm	43	BLACK	6
MUNNS,LISA	120cm	45	BROWN	6
KIM,MAY	117cm	46	BLACK	6
MAHLER,PATRICK	117cm	46	BLUE	6
VEAL JOHN	118cm	46	BROWN	6
FISHER,CHERIE	122cm	46	BROWN	6
CHOE,DANIEL	123cm	46	BLACK	6
WARK,JOHN	119cm	47	GREEN	6
MAN MICHELLE	118cm	49	black	6
HAMMONDS,KARISA	120	50	BROWN	6
LOCKAMY,DIXIE	126cm	50	HAZAL	6
SCOTT,JAMARION	128cm	52	BROWN	7
ROBLEDO,DIANA	117cm	53	BLACK	5
PEAKE,THOMAS T	128cm	54	HAZEL	7
WILKINSON,GERALD	131cm	58	BROWN	6
KIM JEANY	126cm	59	BROWN	7
BELL,MATTHEW	133cm	60	BLACK	6
ROLLINS,MICHELLE	124cm	63	BROWN	6
POLOMSKY,KIM	125cm	65	BROWN	6

Figure 4. Data Base File After Data Has Been Entered.

STUDYING SECOND CLASS LEVERS-

INTRODUCTION

Second class levers are simple machines used to gain a mechanical advantage when attempting a lifting task. The "second class" classification while generally not important is used here only because the classification scheme is used by many textbook authors (Schwartz, 1989; Heimler and Price, 1984). Using this tool, we can lift comparatively large masses while applying only a small force or a little effort. An idealized example of a second class lever is shown in Figure 1. Actual levers consist of a

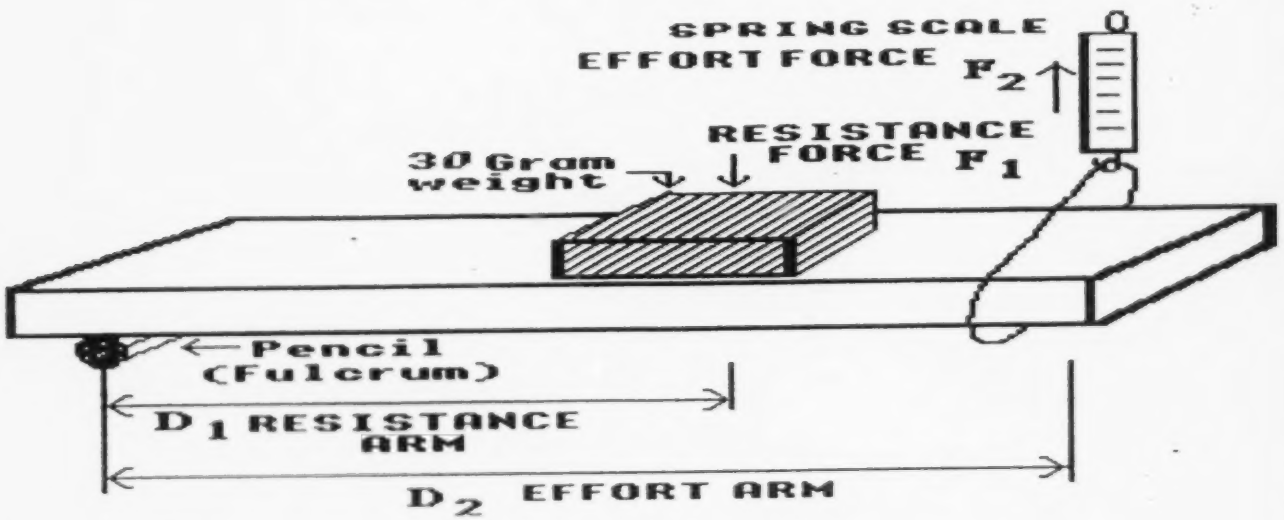

Figure 1. Equipment Setup.

fulcrum and a piece of wood, steel or other material, and the wood or steel piece pivots around the fulcrum when the lever is used. With levers of this class the effort force or the force used to raise an object is applied at the end of the wood or steel piece opposite the end at which the fulcrum is placed. The mass to be raised is located somewhere between the fulcrum and the lifting or effort force. Two distances are important in trying to determine the amount of force required to lift the mass. They are the distance between the center

of the fulcrum and the center of the mass to be lifted (called the resistance arm) and the distance between the center of the fulcrum (see Figure 1) and the center of the applied or lifting force (called the effort force). The minimum effort force (F_2) required to lift a mass (which provides the resistance force, F_1), like a car engine, can be found by solving the equation $F_1D_1 = F_2D_2$ for F_2. From the equation, we see that a decrease in the length of the resistance arm decreases the amount of lifting force required to raise the resistance force. Note, to obtain the actual force, in Newtons, required to lift the mass in kilograms, the mass must be multiplied by the acceleration due to gravity, g ($g = 9.8\ m/s^2$).

PRESENTATION

Second class levers are usually studied in grades five and six and again in greater detail as part of most high school physical science courses. The activity described here, while helping students to understand the benefits, like gaining mechanical advantage, accrued from using this machine instead of simply lifting an object to be moved, provides some concrete experience using a second class lever. In the activity we extend this experience based concrete approach using computer power. The classical approach, where students gather some data about levers as they examine the relationships between resistance force, resistance arm, effort force and effort arm is used. Although the activity starts with the classical approach, students are not provided with the mathematical relationship between these variables. Rather than specifically stating the relationship to students, we have them gather data and search for F_1-D_1 and F_2-D_2 trends after a computer data base file is constructed, research data entered in the file, and the file manipulated several different ways and printed after each manipulation. They are asked to search for and possibly derive an equation which states how the lever functions. While all students may not discover the actual mathematical relationships between the variables, this Piagetian approach provides them an experience base upon which to draw once the mathematics of the lever are discussed in class. Using this approach, students work in research teams while gathering data about the lever, collect data from other students and then use pooled class data and integrate computers into their investigation as they attempt to discover relationships between forces applied to the lever and distances from the fulcrum where the forces are applied.

The AppleWorks computer program and Apple computer are used for the computer component of the activity since they are so readily available in our schools and for that matter, the schools in most U.S. school districts. The program includes a data base subprogram especially useful in science activities. Data base allows students to rapidly arrange and rearrange multivariate data they have gathered. If data trends do exist, using this tool makes them rapidly identifiable since all data may be rearranged numerically within seconds. This data base subprogram also allows users to select, for examination, only certain data records at one time. In this way the variation of two factors like, effort arm and effort force, may be examined while resistance arm and resistance force are held constant.

In addition, using a data base allows students to predict, using, "if - then" logic based upon an apparent trend which surfaces when data are arranged a particular way. The hypothesis may then be accepted of rejected through additional experimentation. The activity provides students experience gathering data, building computer data base files, entering data in the files, manipulating the files, using group process procedures, predicting outcomes, and with the interaction of science and technology. To use the activity, teachers must have some familiarity with the Apple computer and building and manipulating of AppleWorks data base files. Those who are not familiar with AppleWorks program may find background information in the AppleWorks User's Manual which accompanies each purchase of the program. Although the activity can not be completed in a single class period students can finish the data gathering portion in one period. We recommend the activity be completed in phases.

Level Grades 7 through 12.

Science Principles

1. Observing.
2. Hypothesizing.
3. Data Gathering.
4. Data manipulation.
5. Drawing conclusions.
6. Controlling variables.
7. Reading data tables.
8. Using spring scales.
9. Calculating actual mechanical advantage.
10. Calculating ideal mechanical advantage.

Math Principles

1. Solving linear equations.
2. Substitution.
3. Reading scales.
4. Calculating.
5. Formula derivation.

Computer Principles

1. Disk formatting.
2. Program loading.
3. Data base file construction.
4. Data entry.
5. Data base file manipulation.
7. File printing.
8. File storage.

Vocabulary Development

1. Lever.
2. Fulcrum.
3. Resistance force.
4. Effort force.
5. Resistance arm.
6. Effort arm.
7. Format (disk).
8. Load (program).
9. File (computer).
10. Data base (computer).
11. Actual mechanical advantage.
12. Ideal mechanical advantage.
13. Newton.

Partial List of Variables

1. Effort arm length.
2. Effort force (magnitude).
3. Resistance force (magnitude).
4. Resistance arm length.
5. Friction.
6. Mass of the lever.

Materials

1. At least 1 Apple IIe or GS computer.
2. 1 copy of the AppleWorks program (versions 1.2, 1.3, 2.0, 2.1,

3.0 may be used) for each computer.
3. 1 3.5" or 5.25" data disk for each computer (actual disk size depends upon disk drive size).
4. 1 spring scale for each research team. If a spring scale with gram readings is used one would have to convert the reading grams to kilograms and multiply the result by the value for the acceleration due to gravity, g, provided above in the Introduction.
5. 1 round pencil (fulcrum) for each research team.
6. 1 pencil for each student (writing).
7. 1 meter sticks for each research team. Using a meter stick for the lever allows easy determination of the effort and resistance arm lengths.
8. Several pieces of paper for each research team.
9. A variety of masses for each research group such that the group will be able to gather the data shown in Figure 3.
10. 1 ball of string per class.
11. 1 pair of scissors.
12. Several pieces of 8 1/2 x 11" notebook paper for each student.
13. 1 triple arm or other balance for every 4 students.
14. 1 hand held calculator for each team.

Procedures

1. Class Discussion. Conduct a brief class discussion during which levers and the activity are discussed in general terms.
2. AppleWorks Loading. Load the Apple Works program into the computer memory.
3. Data Disk Formatting. Format the data disk. This can be accomplished using option #5, "Other Activities" from the main menu of the AppleWorks program.
4. Computer Data Base File Construction. Each student develops an AppleWorks data base file (the file name is the student's last name). The file includes categories named: effort arm (D_2), effort force (F_2), resistance arm (D_1), resistance force (F_1). Teachers who want their students to calculate actual mechanical advantage (AMA) and ideal mechanical advantage (IMA) should examine Figure 3. It includes IMA, AMA and F_1D_1 & F_2D_2 categories. IMA and AMA of the lever may be computed one of two equations.

   AMA = EFFORT ARM LENGTH/RESISTANCE ARM LENGTH (friction and mass of the lever considered)

   AMA = ACTUAL RESISTANCE FORCE/ACTUAL EFFORT FORCE (friction and mass of the lever considered)

   IMA = EFFORT ARM LENGTH/RESISTANCE ARM LENGTH (friction and mass of the lever not considered)

   IMA = RESISTANCE FORCE/THEORETICAL EFFORT FORCE (friction and mass of the lever not considered)

   The AppleWorks data base file when constructed, will look essentially the same as the table shown in Figure 3, except data

will not have been entered. The computer file may be constructed without the last three categories and if at a later they are needed, they may be added using the OPEN-APPLe and "N" keys.

5. File Saving. Save the file on the data disk using the OPEN-APPLE and "S" keys.
6. Research Teams. Divide the class into teams of 2 students each and give each team a number.
7. Class Discussion. Conduct a class discussion during which the data gathering portion of the activity is discussed. Have students suggest ways of recording the data they collect. A review of the Newton and the procedure for calculating force should be included in the discussion since data entries for force are in Newtons.
8. Constructing a Data Collection Table. Have each student construct a data gathering table for use throughout the remainder of the activity. An example table is shown in Figure 2. Note that team numbers are included here so that if the need arises, a student can talk at a later time to the researchers who gathered a particular datum. Point out the need for neatness. There will be a sizable quantity of data.

TRIAL NO.	TEAM NO.	RESISTANCE ARM (m)	RESISTANCE FORCE (N)	EFFORT ARM (m)	EFFORT FORCE (N)
1	1				
2	1				
3	1				
4	1				
1	2				
2	2				
3	2				
4	2				

Figure 2. Example Data Gathering Table.

9. Materials Handout. Give each research team:
   a. 1 meter stick.
   b. 1 spring scale.
   c. 1 100g mass.
   d. 1 200g mass.
   e. 2 pencils.
   f. 1 piece of string.
   g. Several sheets of notebook paper.
   h. 1 calculator if students are not using their own calculators.

TEAM	D_1(m)	F_1(N)	D_2(m)	F_2(N)	IMA(RF/EF)	AMA(RF/EF)	F_1D_1&F_2D_2 (kgm_2/s^2)
1	0.01000	0.09800	0.02000	0.04900			
1	0.00500	0.09800	0.02000	0.02450			
1	0.00250	0.09800	0.02000	0.01230			
1	0.01250	0.09800	0.02000	0.06130			
2	0.01000	0.19600	0.02000	0.09800			
2	0.00500	0.19600	0.02000	0.04900			
2	0.00250	0.19600	0.02000	0.02450			
2	0.01250	0.19600	0.02000	0.12250			
3	0.01000	0.09800	0.04000	0.02450			
3	0.00500	0.09800	0.04000	0.01230			
3	0.00250	0.09800	0.04000	0.00610			
3	0.01250	0.09800	0.04000	0.03060			
4	0.01000	0.19600	0.04000	0.04900			
4	0.00500	0.19600	0.04000	0.02450			
4	0.00250	0.19600	0.04000	0.01230			
4	0.01250	0.19600	0.04000	0.06130			
5	0.01000	0.14700	0.03000	0.04900			
5	0.00500	0.14700	0.03000	0.02450			
5	0.00250	0.14700	0.03000	0.01230			
5	0.01250	0.14700	0.03000	0.06130			
6	0.01000	0.29400	0.02500	0.11760			
6	0.00500	0.29400	0.02500	0.05880			
6	0.00250	0.29400	0.02500	0.02940			
6	0.01250	0.29400	0.02500	0.14700			

Figure 3. Idealized Data.

10. Mass of the Meter Stick. Have each team determine the mass of their meter stick using the balances provided. The mass per centimeter of meter stick should then be calculated. The mass of the resistance arm must be added to the mass of the object being lifted when data are entered in the data table. In addition, the mass of the meter stick beyond that used for the effort arm must be added to the mass being lifted.
11. Equipment Setup. Setup the fulcrum as shown in Figure 1.
12. Data Gathering. Have each team gather 4 sets of data like those shown in Figure 3. Figure 3 shows data collected by 6 teams. It is not essential for teachers to use the same values as are provided in Figure 3. Teams should be given some data values by their teachers. One is the mass of the object to lifted; they already have that. A second might be the length of the resistance arms to be used. If you want to provide a third, either the length of the effort arm to be used or the amount of effort force to be used can be provided.
13. Data Sharing. Allow a period where each student collects the data gathered by every other team.
14. Data Entry. Have all students enter all of the data gathered by all research teams into their data base file.

15. File Saving. Save the file on the data disk. Students' files should appear similar to the example shown in Figure 4 with two exceptions. IMA and AMA categories will be vacant.
16. File Printing. Print the file by pressing the OPEN-APPLE and "P" keys at the same time.
17. AMA and IMA Calculations. Students calculate AMA and IMA and enter the data in the file.
18. File Saving. Save the file.
19. File Arrangement. Arrange the file numerically on the F1 category. This is accomplished by pressing the OPEN-APPLE and the "A" keys at the same time.
20. File Printing. Print the file.
21. File Arrangement and Printing. Arrange the file numerically on each of the other categories, printing the file each time a new arrangement is made.
22. Printout Evaluation. Allow a period during which students examine the data in the various printouts. This is accomplished by students working in research teams.
23. Class Discussion. Have students discuss their findings and perceptions about second class levers.
24. Answering Questions. Since the values shown in Figure 4 are idealized (friction not taken into account) have students return to their printouts and answer the following questions:
    a. What relationship is there between AMA and D_2?
    b. Is there a relationship between AMA and D_1
    c. What relationship is there between F_1, F_2, D_1, D_2?
    d. Can you design an experiment to prove your findings?
25. Class Discussion. Discuss the $F_1D_1 = F_2D_2$ relationship.

Curriculum Extension.

1. Write a research report about the investigation using the AppleWorks wordprocessor.
2. Write a story about the project using the computer.
3. Using the computer, write a letter to a friend about the project.

SUMMARY

Students who complete this activity engage in a concrete activity where they are encouraged to derive the relationship between resistance force, resistance arm, effort arm and effort force, and increase their understanding of computer power, thus making them more computer literate. If the approach you are presently using to study second class levers has produced less than satisfactory results, why not try this one?

LITERATURE CITED

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BUTTONS, COMPUTERS AND DATA BASE

INTRODUCTION

Whether in our teaching we apply the theories of Piaget, Gagne, use the strategies manifested in John Dewey's now very well known statement, "learn by doing, " or are eclectic as I am, life is integrated both horizontally and vertically, not divided into discrete, neat little boxes. As we plan our school days, therefore, our own backgrounds tell us that new experiences are perhaps better understood when they are concrete, we have actually participated in the experiences, they take into account all factors involved even though several disciplines may be crossed and are repeated from time to time with increasing degrees of sophistication. The activity discussed here could be used in kindergarten. I present it in workshops to show teachers how easily computers can be integrated into a science program. In this endeavor, which has proved highly successful, teachers actually conduct the activity as would their students. In the activity I use rulers, buttons, Apple IIe or GS computers and the AppleWorks data base subprogram. Apple computers are used since there is a vast array of educational software compatible with them. The AppleWorks program is used because it was not specifically designed for use in science and is used (versions 1.2, 1.3 or 2.0 may be used) by many school teachers and administrators as an administrative tool and, therefore, readily available. Let's look at the activity.

PRESENTATION

This activity can be used from kindergarten through adulthood. It involves, measuring, counting, categorizing, group process, construction of computer data base files (thus computer literacy), construction and/or use of data tables, data gathering, making observations, the study of shape for kindergartners, the computation of area, the computation of volume, the manipulating and printing of computer files and the evaluation of data trends. For older students and adults, writing skills and/ or scientific writing may be added to the list. Teachers choosing to use the activity should know how to load the program into the Apple IIe or GS computer, construct an AppleWorks data base file, print, store and manipulate files. At this point, I need to say a word about the group process since it is used in this activity, kindergarten through adulthood. Group process is simply working together in research teams to solve a problem, answer a perplexing question or reach a goal, a technique used so very well these days in Japanese society. A second note needs to be made about the lower grades. Here are students starting to learn much about the scientific method as they categorize blocks by color, shape and size. As they grow older the way in which items are categorized becomes more sophisticated as data trends and the like are sought. Students, on their own, conclude that the blocks may fit into different categories like area, volume, thickness, texture and so on.

This activity uses a random collection of buttons. Since finger dexterity is still developing with young children, you may want to use larger buttons and/ or stay with blocks for kindergarten children and first graders. In addition, you may want to have some younger students conduct only the categorization portion of the activity, especially if you perceive that conducting the complete activity is difficult. After investigating the problem, that is, gathering as much data as possible in some organized fashion (the organization again varies with the age of students, experience of each student, background of the teacher and the collective experience of each research team) students work individually on the computer depending upon their experience constructing data base files, entering data and so on. Organization may mean, teacher making a list on the chalkboard to very sophisticated tables like the one included at the end of this article. Once the data gathering phase has been completed, a computer data base file is built, data entered in the file and the data base manipulated as data trends are sought.

Teachers who wish to have their students derive the volume of each button should use the water immersion technique. Accordingly, each button is submerged in a known volume of water as follows. A graduated cylinder is filled to a specific level, say 50 milliliters, after a weight like a washer or fishing sinker has been placed in the cylinder (tie a piece of thread to the weight so it can be retrieved from the cylinder). The volume is

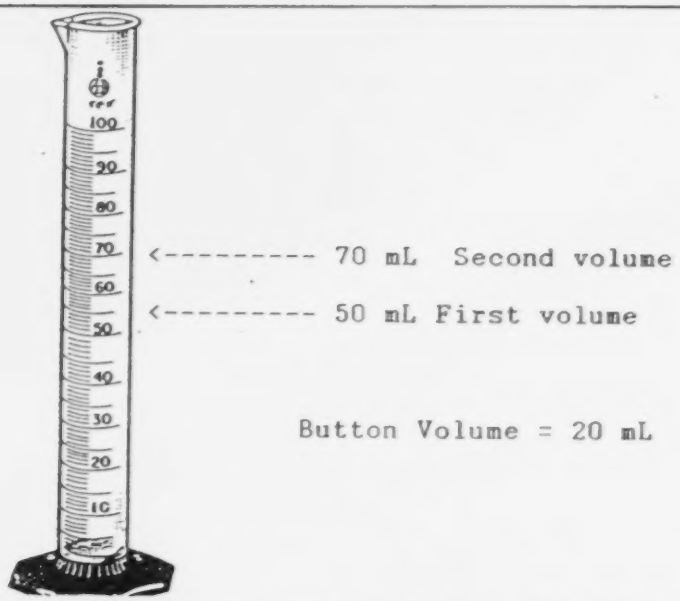


Figure 1. A Graduated Cylinder, Submersion Weight and a Button.

recorded. Then, one end of a piece of thread is tied to the sinker and the other end to the button. Next, a second piece of thread is tied to the button. This second piece of thread is used to lower the sinker-button combination in and out of the graduated cylinder (see Figure 1). A larger graduated cylinder may be needed if extremely large buttons are used.

Next, the sinker and button are lowered into the water and the new volume recorded. Once the new volume is recorded, the original volume is subtracted from the new volume to derive the volume of the button. When determining the volume of several buttons, care must be taken not to lose any of the water from the graduated cylinder. In addition, the same weight must be used each time a button is submerged (control of a variable) since the volume may differ between one weight and another.

Grade Level. Kindergarten through adulthood.

Science Processes.
1. Observing and classifying.
2. Gathering and recording data.
3. Measuring.
4. Manipulating data.
5. Controlling variables.
6. Evaluating data.
7. Logical thinking.

Math Skills.
1. Counting.
2. Sorting.
3. Recording data.
4. Comparing.
5. Measuring length.
6. Computing area.

Computer Skills.
1. Loading a program.
2. Data base file construction.
3. Data base manipulation.
4. Printing.
5. File saving.
6. File data entry.

Vocabulary.
1. Boot (load).
2. Data base.
3. Data.
4. Variable.
5. Classification.

Materials.
1. A random collection of buttons; approximately 5 buttons per student.
2. A centimeter or other ruler for each student (ruler may be omitted for kindergarten students).
3. A pencil for each student.
4. Three or four sheets of paper for each group of students (3 - 4 students per group; may be omitted for kindergarten students).
5. Apple IIe or GS computers, one with a printer.
6. AppleWorks startup and program disk (version 2.0 on a 3 1/2" disk may be used) for each computer.
7. A blank computer data disk (5 1/4") for each computer.
8. For volume derivations, one 100 ml graduated cylinder for each group.
9. A spool of thread.
10. A fishing sinker or washer for each group (volume computation).
11. Chalkboard and chalk.

Partial List of Variables.
1. Shape; round, square, rectangular, oblong, triangular.
2. Color.
3. Number (in the sequence - 1, 2, 3 etc.).
4. Number of holes per button.
5. Diameter.
6. Length.
7. Width.

8. Thickness.
9. Volume (may be used with high school students, talented and gifted (TAG) students and adults - requires a water immersion to derive).
10. Surface area.
11. Texture.

Procedures.

1. Grouping Students. Divide the class into groups of 3 to 4 students each.
2. Supplying Materials. Give each student a ruler, pencil and a sheet of paper.
3. Supplying Materials. Give each group a random collection of buttons, approximately 5 buttons per student.
4. Discovery Period. Allow students 10 minutes to see what they can discover about the buttons.
5. Brainstorming. Conduct a class brainstorming session (about 5 minutes) during which students make suggestions regarding what can be learned about the buttons they have, using their own skills and a ruler. List student suggestions on the chalkboard. The discussion should be guided so that the list includes those variables listed above.
6. Data Gathering. Allow the students approximately 10 minutes to gather data about their buttons (time needed will vary with the experience of the students). Each student gathers data about his or her buttons.
7. Data Sharing Within Groups. Have students share their data so that all students in the group have each other's data.
8. Brainstorming. For older students, conduct a second brainstorming session, in which, students make suggestions about how to organize the data as it is gathered. Suggest students develop a form similar to the one that accompanies this activity (see Figure 2).
9. Data Organization. Allow approximately 5 minutes to organize the data.
10. Program Loading. Load the AppleWorks program into the computer. The teacher may need to do this step for some younger students.

DATA COLLECTION TABLE

ITEM NO.	SHAPE	COLOR	HOLES	DIAMETER	LENGTH	THICKNESS	VOLUME	SURFACE AREA	TEXTURE	OTHER

Figure 2. Example Data Collection Table.

11. Disk Formatting. Format the blank data disk. Teachers may need to do this for younger students.
12. Data Base File Construction. Construct a new data base file. Include variables in the file from the brainstorming session and the data table if applicable. The directions seen on screen must be followed (see Figure 3).
13. Data Entry. Enter the data gathered during the data gathering session into the file (the file will have a record for each button).
14. File Storage. Store the file.
15. Printing. Print the file.
16. File Arrangement. Manipulate the file various ways using the OPEN-APPLE and "A" keys option.
17. Printing. Print each new arrangement.
18. Print Sharing. Give each group of students a copy of the data base
file arrangements.
19. Data Examination. Allow students a period to examine data trends evidenced as a result of the computer data manipulations.

20. Class Discussion. Conduct a class discussion in which students discuss trends discovered as a result of the data base file manipulations.

File: ButtonsDB REVIEW/ADD/CHANGE Escape: Main Menu

Selection: All records

NO.	SHAPE	COLOR	HOLES	DIAMETER	LENGTH	WIDTH	THICKNESS	VOLUME	SURF AREA	TEXTURE
-	-	-	-	-	-	-	-	-	-	-

Type entry or use @ commands @-? for Help

Figure 3. An Example Data Base File.

Curriculum Extension.

1. Write a report of the investigation using the AppleWorks word processing subprogram and the computer.
2. Write a story about the project using the computer.
3. Write a letter to a friend about the project. The letter is composed while using the computer.

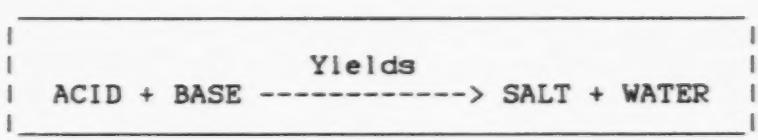
TESTING FOR ACIDS AND BASES

INTRODUCTION

Of the many categories of chemicals we know and can easily identify, two are called acids and bases. They react differently with another category of chemicals known as indicators. If we pour hot water over red cabbage and let the mixture sit a few moments, the water turns purple. The purple water is an indicator. The chemicals which made the water purple (and also make the cabbage leaf red) react differently to acids than they do to bases (sometimes we say acidic or basic chemicals). When the cabbage water is mixed with an acidic substance the color changes from purple to pink. Basic chemicals turn the cabbage extract from purple to green. A branch of chemistry in which various tests like the acid and base tests we do here, are done on other unknown chemicals to determine what they are is called qualitative analysis.

There are, of course, other ways to test for acids and bases. Taste, although not recommended unless you know the substance you are tasting is one. Acids taste sour while bases taste bitter. Another, which again is not highly recommended, is touch. Bases are slippery. Yet another is to use indicator paper for which there are several names like pH paper, litmus paper and so on.

When acids and bases are mixed together, two new chemicals are formed; one is a salt and the other is water. The general reaction occurring when acids and bases are mixed together is:



This reaction, where the arrow means "yields" is sometimes called a neutralization reaction.

PRESENTATION

Students who conduct this activity work in pairs (research teams) as they gather data. Data gathered during the activity is eventually shared among all research teams as the teams attempt to determine whether or not the tests always produce the same results. To make the task of data analysis as easy as possible, each research team builds a computer data base file, manipulates or arranges and prints their file. The file printouts are subsequently studied as the teams try to determine whether the results are consistent each time a test is conducted.

Teachers electing to use the computer portion of this activity should know how to construct, store and print AppleWorks data base files.

Grade Level. Grades 3 - 8. Grades 1 and 2 students may also be able to do part of this activity and see the color changes.

Science Skills
1. Observing.
2. Critical Thinking.
3. Data Collection.
4. Measuring Temperature.
5. Estimating.

Computer Skills
1. Data Base File Construction.
2. File Printing.
3. File Storage.
4. File Arrangement.
5. Program Loading.
6. Data Input.

Math Skills
1. Measuring.

Vocabulary
1. Acid.
2. Base.
3. Indicator.
4. Acidic
5. Basic
6. Reaction.
7. Neutralization
8. Litmus paper
9. Salt.
10. Centimeter (cm).
11. pH.
12. Liter.
13. Yield.
14. Data Base.
15. Load (boot).
16. Print.
17. Category.
18. Field.
19. Arrange.
20. Store

Materials.
1. 1 teaspoon.
2. A quantity of baking soda.
3. A quantity of white vinegar.
4. 10 test tubes (pill bottles without childproof caps).
5. 2 empty baby food jars.
6. 3 large wide mouth jars (quart size) or other pans which can be used for hot water.
7. 1 cardboard tray (any flat piece of cardboard will work).
8. Paper napkins.
9. 1 quart of lemon juice per class.
10. 1 quart of shampoo per class.
11. 1 quart of laundry detergent per class.
12. 1 quart of orange juice per class.
13. 1 hot plate or other heating device per class.
14. 1 thermometer per class (optional).
15. 1 pencil for each student.
16. 2 pieces of notebook paper for each student.
17. 1 centimeter ruler for each student.
18. 1 pair of scissors for every 6 students.
19. Approximately 1 liter of tap water (unheated).
20. Apple IIe or GS computer(s) with printer(s) for each class.
21. 1 copy of the AppleWorks program for each computer (versions 1.2, 1.3, 2.0, 2.1 or 3.0 may be used (2.1, 2.1 and 3.0 are generally used only with the GS computer.
22. 1 blank data disk for each computer (size will depend on disk drive size being used).

Procedures

1. Before Class - Making the Indicator (older students can also do this).
   a. Heat Water. Heat enough water to fill the quart sized container to about 90 °C or about 200 °F.
   b. Cabbage. Cut or tear the cabbage into small pieces and stuff them into the quart container.
   c. Pour Water. Pour the heated water slowly over the cabbage leaves. Then allow the jar or container to sit until the water turns purple.
   d. Second Volume of Indicator. You may, depending upon the size of your class, need to make a second volume of indicator.
2. Removing the Indicator. Pour indicator (purple water) into a second jar.
3. Research Teams. Divide the class into two student research teams.
4. Pouring Paper. Have each student cut a square piece of paper, 12 centimeters (cm) on each side.
5. Paper Folding. Fold the paper lightly in half.
6. Equipment and Materials. Have students gather the necessary materials and equipment from their chemistry sets. Only one set of materials is needed for each research team.
7. Baking Soda. Have each research team measure 1/2 teaspoon of baking soda and place it on the 12 cm square folded piece of paper.
8. Water. Fill 1 test tube (large pill bottle 1/2 full of tap water.
9. Purple (cabbage) Indicator. Give each research team approximately 1/2 of a test tube of purple indicator.
10. Inquiry Period. Allow a brief period during which students see what they can find out using the chemicals and equipment on their trays. If they add baking soda to water an acidic solution is produced. When the soda water is mixed with the indicator the solution should change color from purple to pink indicating the solution is acidic (Ask how many research teams got these results?).
11. Second Mixing. Without telling students what the outcome should be, have them conduct the experiment again as follows:
    a. Add 1/2 teaspoon of baking soda to 1/2 a test tube of tap after.
    b. Add the purple indicator to the test tube of water, filling the test tube.
    c. Observe.
12. Class Discussion. Conduct a class discussion during which acids and bases are discussed as they are in the introduction above.
13. Data Collection Table. Have each team make a data collection table similar to the one shown in Figure 1.

CHEMICAL NUMBER	CHEMICAL NAME	COLOR AFTER ADDING INDICATOR	BASIC	ACIDIC
1	Water	Pink		X
2	Soda Water	Pink		X
3	Detergent	Green	X	
4				
5				

Figure 1. Example Data Collection Table.

14. Data Recording. Have students record their data on a form like the one above, including the results of the soda water test.
15. Vinegar Test. Have each research team:
    a. Fill a test tube 1/2 full of the white vinegar.
    b. Fill a test tube 1/2 full of indicator.
    c. Mix the contents of the two test tubes and record the results.
16. Class Discussion. Discuss the results of the last test; what obvious difference appeared when the two liquids were mixed?

File: DB ACIDS BASES REVIEW/ADD/CHANGE Escape: Main Menu

Selection: All records

TEAM NO	CHEMICAL NO	CHEMICAL NAME	COLOR AFTER IND ADD	BASIC	ACIDIC
1	1	Water	Pink	-	X
1	2	Soda Water	Pink	-	X
1	3	Detergent	Green	X	-
2	1	Water	Pink	-	X
2	2	Soda Water	Pink	-	X
2	3	Detergent	Green	X	-
3	1	Water	Pink	-	X
3	2	Soda Water	Pink	-	X
3	3	Detergent	Green	X	-
4	1	Water	Pink	-	X
4	2	Soda Water	Pink	-	X
4	3	Detergent	Green	X	-
5	-	-	-	-	-
5	-	-	-	-	-
5	-	-	-	-	-

Type entry or use @ commands @-? for Help

Figure 2. Example Data Base File With Some Data Entered.

17. Chemicals Handout. Give each research team 1/2 a test tube of each of the following chemicals without giving them the chemical names (they should mark the test tubes 1, 2, 3, 4, 5.

a. Tap water.
b. Shampoo.
c. Laundry detergent.
d. Orange juice.
e. Lemon juice.

18. Indicator. Give each team 5, 1/2 full test tubes of indicator.
19. Mixing. Mix the indicator with the 5 unknown chemicals and record the unknown chemicals and record the results.
20. Names. Provide students with the names of the unknown chemicals.
21. Data Sharing. Allow a period where research teams gather all the data collected by all research teams.
22. Team Numbering. Explain how the research team numbers are used. The numbers are used when data is entered in the data base file.
23. Data Base File Construction. Have each research team construct a data base file as follows:
    a. Booting AppleWorks. Load the AppleWorks program into the computer.
    b. Format the Data Disk. This can be accomplished by selecting option #5 from the AppleWorks "Main Menu" and then option #5 from the "Other Options" menu.
    c. File Construction. Construct a data base file. An example is provided in Figure 2. This file name could be the last name/s of one or both members of the research team.
    d. Data Entry. Enter all data from all research teams in the file.
    e. File Storage. Save the file by pressing the OPEN-APPLE and the "S" keys at the same time.
    f. File Printing. Print the file by pressing the OPEN-APPLE and the "P" keys at the same time.
    g. File Arrangement and Printing. Rearrange the file on each category or field (categories or fields are vertical columns in a data base file. Print the file after each rearrangement.
24. Data Examination. Allow a period where each research team examines the data.
25. Class Discussion. Conduct a class discussion regarding the results of the investigation identified by computer printouts. Were the results of the tests consistent across research teams?

Curriculum Extension.

1. Additional Substances. Give students samples of other substances and have the substances tested to determine whether they are acidic or basic. Some examples of other substances that can be used are: soil, grapefruit juice, clorox, 7-up.
2. Saliva Testing. Obtain some litmus paper (often can be purchased at drugstores) and have students test their saliva to see if it is acidic or basic. Litmus paper comes in two colors, pink for testing bases and blue for testing acids. A color change in either paper as the result of testing means the substance being tested is either acidic or basic. Pink litmus paper turns blue in the presence of a base; blue litmus turns pink in the presence of an acidic substance.
3. Report Writing. Have students write a report about the activity they conducted using the word processing portion of the AppleWorks program.
4. Letter Writing. Have students write a letter to a parent or a

friend, describing the activity they have conducted. The letter could be written using the word processing option of the AppleWorks program.

SUMMARY

In this activity students are introduced to the subject of qualitative analysis as they evaluate substances to determine whether they are acidic or basic. If their teachers desire, students could also conduct a computer data base test on their data using data provided by other research teams to ascertain whether their results were consistent with those of other student researchers or perhaps the result of some fluke in the testing procedure or a random, unidentified, intervening variable. The activity may be conducted with or without the computer component and was written in a concrete manner so that users having limited science backgrounds may use it with the same degree of confidence and success as those with more extensive backgrounds.

STUDYING THE CHEMISTRY OF FIRE AND ATMOSPHERIC PRESSURE

INTRODUCTION

Air is composed of a cloud of atoms and molecules called a gas. It is not a single gas actually but a collection of gases. We that atoms and molecules have mass and, therefore, so does the air around us. Gravity effects the air mass and as a result, the air mass applies a pressure to all things on earth's surface. We don't normally think of the force exerted upon us by atmospheric pressure because our bodies are acclimated to the pressure and we exist in a state where our bodies apply a pressure outwardly equal to the inward pressure applied on them by the mass of the air around us. The same pressure relationships exist with all objects on earth and we say a state of dynamic equilibrium exists. The balance changes whenever one of the forces change. If for example, atmospheric pressure decreases in response to atmospheric disturbances near a sea coast, the sea level rises. To many of students, these concepts are somewhat abstract since if one looks at the sea during a low pressure period, the increase in sea level is not perceptible, air cannot be seen thus the idea of it having mass is not easily understood, most of us do feel our bodies respond to changes in atmospheric pressure and so on. There are, however, ways in which students can study the results changes in the dynamic balance.

One of the molecules, occupying approximately 21% of the total air volume, is the colorless, odorless gas we call oxygen (its molecular formula as it exists in air is O_2). When a material burns (or oxidizes), after reaching kindling temperature, oxygen combines chemically with the burning substance. Burning continues as long as the material is above the kindling temperature and oxygen is present. In addition to oxygen depletion as a result of something burning, the air around the burning object is heated, becomes thinner, the oxygen molecules close enough to the burning object to combine in the oxidation process decrease without a constant supply and eventually oxidation ceases (the fire is extinguished). This is especially true in a closed system like a candle burning in a covered jar.

When materials wood or gasoline burn, new molecules are formed. The molecules resulting process often are other colorless gases like carbon monoxide (CO) and carbon dioxide (CO_2). In the presence of ample supplies of oxygen, carbon monoxide rapidly changes to carbon dioxide further depleting the oxygen available for the burning process. As we can see, the heating of the air around a burning substance, the chemical combination of atoms to form new compounds, and change in space requirements to accommodate the newly formed compounds are good reason to think that the dynamic equilibrium of a system interfacing directly with the surrounding atmosphere will be upset, and it is. These principles are in the following activity to allow students to examine the effect of atmospheric pressure.

In this activity, students gather and computerize data as they try to understand the effects of fire on a local environment. In so doing, they work in research teams while gathering data, pool their

data with that of other teams and, construct Apple computer data base files as they try to develop a model of earth's air mass effect based upon data arrangements provided by the computer. Conclusions regarding the air mass effect are sought following students examination of data base file printouts. Teachers electing to use the computer portion of the activity should know how to create, store, print and arrange AppleWorks data base files. Help for teachers can be found in the AppleWorks users manual which comes in the package with the purchase of the AppleWorks program.

PRESENTATION

When something burns in a closed system, oxidation of the substance being oxidized usually continues only until the available oxygen supply is depleted. One such system is shown is Figure 1. The system functions as follows: the candle is lighted and the glass jar placed over the burning candle (see Figure 2). As the air is heated and the oxygen combines chemically, the volume of air in the jar changes and the water (H_2O) level in the jar rises in direct relation to the atmospheric pressure. The level continues to rise in the jar until a condition of dynamic equilibrium has been reestablished again and the pressure caused by the air in the jar equals the atmospheric pressure.

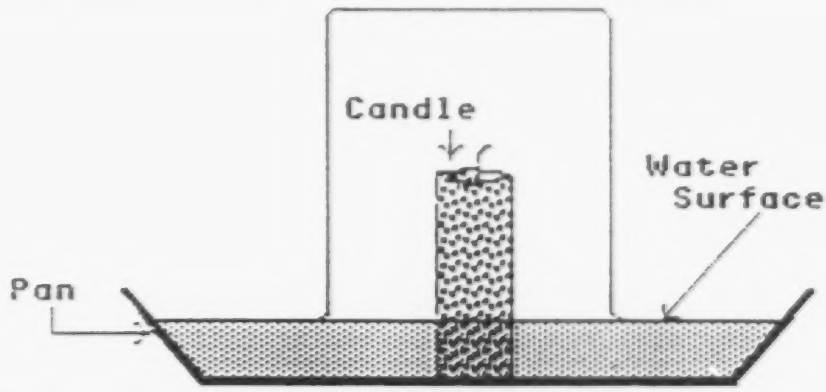


Figure 1. Example of the Closed System.

Grade Level. Grade 3 through College

Teacher Centered Objectives

1. Provide students with experience examining the effect of atmospheric pressure.
2. Provide students with experience integrating science and technology with research techniques to find concrete evidence of complex environmental phenomena.
3. Provide students with experience using the computer as a tool.

Science Skills
1. Observing.
2. Measuring.
3. Hypothesizing.
4. Drawing Conclusions.
5. Volume determination.

Computer Skills
1. Program Loading.
2. Disk formatting.
3. Data Base File Construction.
4. File Storage.
5. File Printing.
6. File Arrangement.

Partial List of Variables.
1. Jar size.
2. Candle volume
3. Atmospheric pressure.
4. Altitude at which the activity is conducted.
5. Atmospheric pressure on the day the activity is conducted.

Math Skills
1. Computing volume ($V = r^2h$).
2. Measuring.
3. Subtraction.
4. Multiplication.

Vocabulary
1. Variable.
2. Volume.
3. Burns.
4. Oxidizes.
5. Carbon Monoxide.
6. Carbon Dioxide.
7. Oxygen.
8. Molecular Formula.
9. Gas.
10. Centimeter (cm).
11. Kindling Temperature.
12. Milliliter (mL).
13. Liter (L).

Materials
1. 1 jar for each pair of students. Jars should be straight sided and of differing sizes (have students bring jars, large peanut butter and mayonnaise jars work well).
2. 1 small candle (the candle must be short enough so that it can be covered by the jar and enough space above the candle in the for the flame) for each research team (pair of students). Candle size is related to jar size.
3. 1 book of matches for every 4 research teams.
4. A quantity of water for each research team.
5. 1 dish or pan for each research team. The container should have sides approximately 5 cm high.
6. 1 grease pencil for each research team.
7. 1 centimeter ruler for each research team.
8. 1 pencil for each student.
9. Several pieces of notebook paper for each team.
10. At least one Apple IIe or GS computer with printer for each class.
11. 1 blank data disk for each computer.
12. 1 AppleWorks program for each computer (Versions 1.2, 1.3, 2.0 and 2.1 may be used (V2.0 and 2.1 generally are used only with the Apple IIGS Computer).
13. A 100 milliliter (mL) graduated cylinder for each research team (other size cylinders will work, if cylinders are not available, a measuring cup could be used, graduations on such cups, however, are usually gross, allowing for the possible introduction of experimental error).
14. Approximately 2 liters (L) of water for each class of 24 students.
15. Water containers.
16. 1 centimeter ruler for every 4 research teams.

17. 1 small container of food coloring for each class (any color - using colored water makes the rise in water level inside the jar more dramatic).

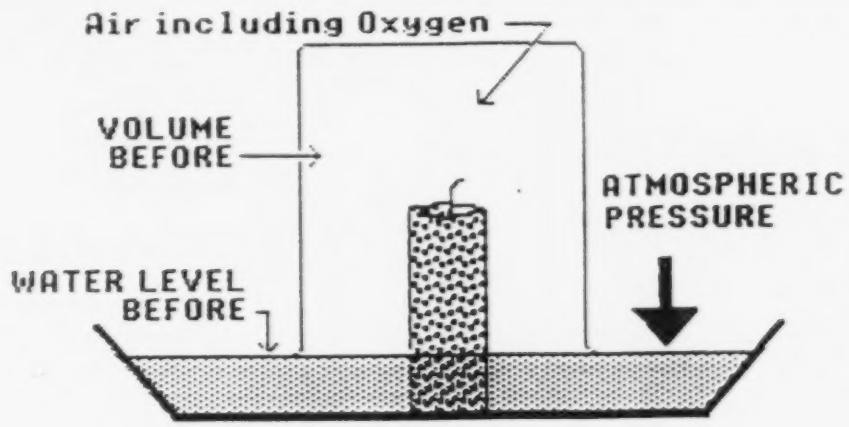


Figure 2. Example of the Closed System Prior to Lighting the Candle.

Procedures

1. Grouping Students. Divide the class in research pairs (teams).
2. Materials Handout. Handout all of the materials to students except the water.
3. Equipment Setup. Describe the equipment setup to students and draw a picture of the setup on the chalkboard (see Figure 1).
4. Candle Setup. Have each group setup their candle in their dish or pan. This can be accomplished by allowing a few drops of wet wax to fall on the spot where the candle is to stand and then place the candle on the pool of wet wax.

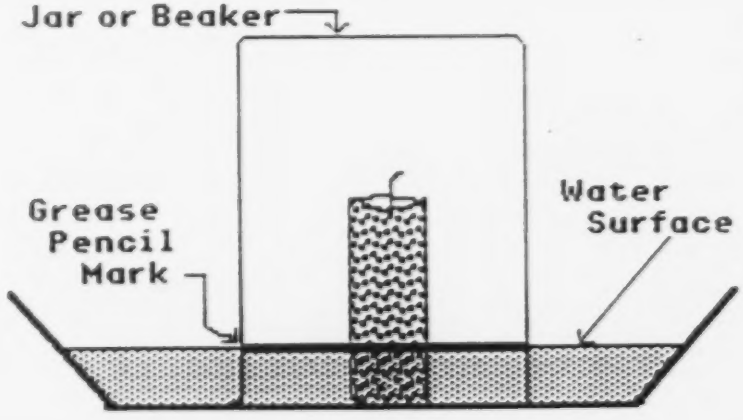


Figure 3. Marking the Jar.

5. Water. Fill each dish or pan with water to a level of approximately 3 cm.
6. Food Coloring. Add 1 or 2 drops of food coloring to the water in each pan.
7. Marking the Jar. Cover the candle with the jar and, using the grease pencil, mark the jar, at the top of the water (see Figure 3).
8. Jar Volume Computation Methods. Compute the volume of the air in the jar above the water surface ($V = pi \times r_{2h}$).
   a. Method 1. Use the formula for the volume computation.
   b. Method 2. Fill the jar with water to the grease pencil line. Then, pour the water into the measuring cup or graduated cylinder, recording the water volume which in turn, since the jar is inverted when data are drawn, is the required jar volume.

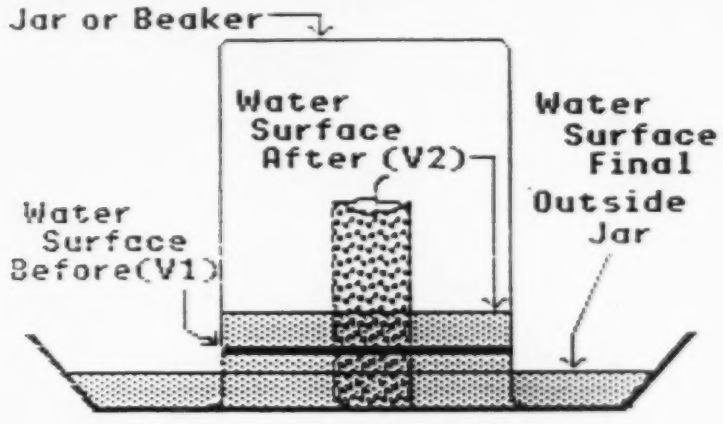


Figure 4. Marked Jar after the Candle Goes Out.

9. Candle Volume Computation. Although the candle may be small (activity works with a birthday cake candle) students should be helped to see that we must take all factors into account if we are to be as exact as possible with the computations.
   a. Method 1. Make a grease pencil mark on the candle at the water top, then compute the candle volume above the mark using the volume formula provided above.
   b. Method 2. Place a known volume of water in the graduated cylinder (50 millliliters (mL), then place the candle in the cylinder and gently push it below the surface using the pencil. Now read the new volume. Subtract the first volume from the second volume. The volume change is the candle volume.
10. Final Air Volume Computation Before The Candle Is Lighted. Subtract the candle volume from the air volume of the jar. The resulting figure is the volume of air actually remaining in the jar when the burning candle is covered by the jar.
11. Lighting the Candle. Remove the jar, light the candle and replace the jar over the burning candle.

12. Jar Marking. After the candle goes out, mark the jar at the top of the water (see Figure 4).
13. Volume Computation After The Candle Is Extinguished. Compute the volume of air remaining in the jar following extinction of the candle as follows:
    a. Compute the volume of the space remaining above the second grease pencil mark using either method described in #8.
    b. Place the candle next to the jar, lining up the grease pencil mark on the jar (first mark) and that on the candle.
    c. Make a second mark on the candle and determine the volume of the candle above the second mark using the method described in #9 above.
    d. Subtract the candle volume from the jar volume to determine the actual volume of gases remaining above the water surface.
14. Change in Volume Computation. Subtract the second gas volume computation (#13) from the first computation. The answer is the change in gas volume caused by the oxidation process (see Figure 5).

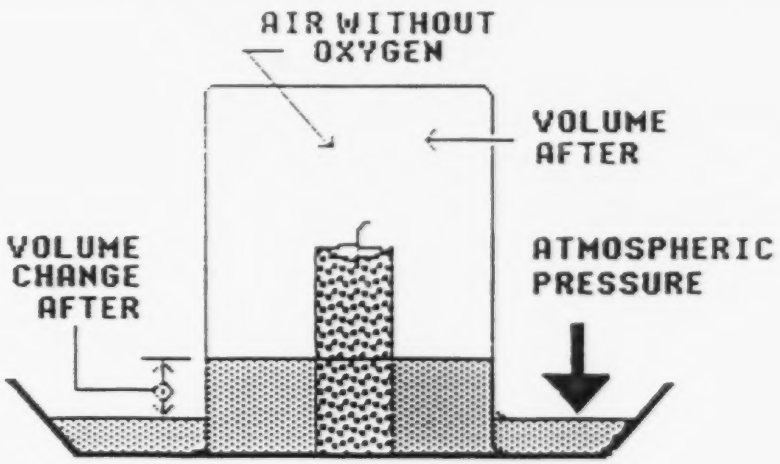


Figure 5. Computing Volume Change of Marked Jar.

15. Data Sharing. Allow a period during which every student gathers all data thus far collected by all research teams.
16. Compute Percent. Compute the percentage volume change:

$$\frac{V1-V2}{V1} \times 100$$

17. Disk Formatting. Format the blank data disk. The task is accomplished by choosing option #5 from the AppleWorks, "Main Menu" followed by option #5 from the, "Other Options" menu and

then following the directions presented on the computer monitor screen.

18. Data Base File Construction. Have each student construct an AppleWorks data base file (see Figure 6). Each team is a sample and each sample has 1 record in the file. The file name could be the student's last name.

File: FIRE.CHEMISTRY. REVIEW/ADD/CHANGE Escape: Main Menu

Selection: All records

JAR.NO	OR.JAR.VOL	OR.CANDLE.VOL	V1	F.JAR.VOL	F.CANDLE.VOL	V2	V1-V2/V1x100
1	500mL	50mL	450mL	400.5	45mL	355.5	21%
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-

Type entry or use @ commands @-? for Help

Figure 6. Example Data Base File.

19. File Storage. Save the file on the data disk. This can be accomplished by pressing the OPEN-APPLE and the "S" keys at the same time.
20. File Printing. Print the file. This can be accomplished by pressing the OPEN-APPLE and the "P" keys at the same time and following the directions provided on the screen
21. Data Entry. Enter all data in the file.
22. File Storage. Save the file on the data disk.
23. File Manipulation. Manipulate the data base file on each category by pressing the OPEN-APPLE and the "A" keys at the same time and following the directions provided on the screen.
24. File Printing. Print the file each time it is rearranged.
25. Printout Examination. Allow a period where students examine the printouts, looking for data trends.
26. Class Discussion. Conduct a class discussion where students are led to the conclusion that the volume of oxygen in the air sample is or was 21%.

Curriculum Extensions.

1. Have students write a report about the activity using the word processing portion of the AppleWorks program.
2. Have students write a letter to a friend describing the activity they have conducted.

SUMMARY

Students conducting this activity investigate the effect of earth's atmosphere in the area or a fire. While accomplishing this task, they are also studying the effect of earth's atmosphere on the environment. Although the effect of the air mass cannot generally be felt directly by humans, its effect is seen when the water level rises in the jar in response to changes caused by a burning candle.

When investigations like this one are conducted, student researchers make use of the scientific method, research teaming and pooled data. Using pooled data is especially important since it increases the quantity of data available for analysis and therefore helps rule out the possibility that the effects we see are caused by some random intervening and otherwise unknown variable.

As students examine their computer printouts they do not necessarily immediately see relationships between data categories. Some teams will have higher percent change figures than others. These differences are caused by factors like experimental error, use of differing sized candles and jars and so on. Investigators must extrapolate from the data as they make statements about environmental pressure and composition. Teachers should differences in data as point of departure for further student research and, discussions about experimental error and the control of variables.